Ph.D. in Information Technology
Thesis Defense

November 12th, 2024
at 10:00 a.m.
Room Alpha

Enrico RONCONI – XXXVI Cycle

HIGH-PERFORMANCE GENERAL-PURPORSE DIGITAL ARCHITECTURES FOR ELABORATION OF TIME-RELATED MEASUREMENTS
Supervisor: Prof. Angelo Geraci

Abstract:

Time measurement is essential in many academic, research and industrial fields such as high-energy physics, medical imaging, computer vision, spectroscopy and many others, where the time-of-flight of various particles is used to infer another physical dimension of interest. Being time measurement important in many fields, various Time-to-Digital Converters (TDC) solutions have been developed in both the academia and the industry.

Time precision is the main figure of merit of TDCs, but the number of input channels and maximum measurement rate are the current bottleneck in many applications.

Those requirements are pushing the challenges in the design of such instruments away from the time-measurement core towards the data elaboration part, which should be able to manage, elaborate and transmit or store an enormous amount of data produced by the measurement core.

Given such strict requirements, in many projects the time converters are developed and optimized ad-hoc to carry out the specific task. While this approach can be sustained for large and medium scale applications, it is inconvenient for research tasks or niche projects where the human and economic resources are often not enough to develop an efficient time converter solution.

While readily-available general-purpose time converters do exist, they often lack the needed performance or they have been heavily optimized for a particular application making them very difficult or nearly impossible to be used for different setups other than the original one.

The aim of this work is to fill the above focused gap by providing an high-performance, general-purpose time converter that can be easily integrated in a wide number of different experimental setups during the research and development in both the academia and the industry. As an analogy, this work can be seen as an attempt to create an instrument as flexible and useful as an oscilloscope, that instead of analyzing the amplitude of signal, determines their time of arrival.

In order to achieve this ambitious goal, several software solutions and FPGA-implemented digital architectures have been developed, leading to the creation of an innovative high-performance, general-purpose, easy to integrate desktop TDC device. The instrument has been validated during

various collaboration with external laboratories that carried out a wide range of time-resolved experiments using the developed device.

PhD Committee

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